Is Design Guidance for Roads incomplete?

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Is Design Guidance for Roads incomplete?

Dr. Robert Eadie, Dr. Phillip Millar and Mr. John Boyle

***Abstract*— A consultation on draft high level guidance for road design of streets in town and city centers in Northern Ireland ended in October 2013. The addition to the guidance through this proposal needs examples to allow designers to apply the high level guidance mentioned in practical situations. For mixed use developments in Northern Ireland designers have to apply the Design Manual for Roads and Bridge (DMRB) and seek formal departures and relaxations through the planning service in order to gain approval for proposals for a development. This is an unwieldy process and recognizing this, the authorities in England, Scotland and Wales have moved to provide design guidance. Northern Ireland has therefore fallen behind in in this respect. Seven case studies in the Belfast City Council area which is the largest council in Northern Ireland are used in this paper to provide a gap analysis in the existing legislation and suggest ways the current consultation proposal could be implemented on the ground.**

Keywords—Highways, Legislation, Design, Guidance

I. Introduction

TransportNI comprise the sections of the Department of Regional Development (DRD), the overseeing authority in Northern Ireland, that deal with Highway issues [1]. In the UK the Design Manual for Roads and Bridges (DMRB) [2] is the geometric design standard used for trunk roads including motorways. The DMRB was initially produced in 1992 in England and was subsequently adapted for Scotland, Wales and Northern Ireland [3]. TransportNI are responsible for overseeing its application in Northern Ireland. Two other design guides have been jointly produced by TransportNI for guidance on new residential developments and private accesses:Creating Places (Residential Design) [4] and Development Control Advice Note 15 (DCAN15) (Private Access Design) [5]. The role of these documents in the geometric aspects of design for Highways in Northern Ireland is summarised in Table1.

TABLE I. CURRENT DESIGN GUIDANCE

Design Guidance	*Geometric Applicability*
Design Manual of Roads and Bridges (DMRB)	Trunk Roads
Creating Places	Residential Developments
Development Control Advice Note 15	Private Access Design

This demonstrates a gap in the literature relating to *mixed use* developments that do not have a residential section. The Creating Places document [4] states "*This guide is intended for use in the design of all proposals for residential development throughout Northern Ireland, from small-scale infill housing schemes to major projects on large sites incorporating a mix of uses*". This limits the Creating Places guidance to sites with a residential element.

II. Identified Gap in Guidance

The Creating Places document [4] was published in 2000 for Northern Ireland use only. In England and Wales, Design Bulletin 32 [6] and Places Streets and Movement documents [7] remained in use up to 2007, when the Manual for Streets (MfS1) [8] was published. This defined a street as a highway *"that has important public realm functions beyond the movement of traffic"* and *"Most highways in built up areas can therefore be considered as streets"*.

Early (2007) [9] highlighted that the publication of the MfS1 [8] still did not close the knowledge gap for secondary streets and stated that the Department of Transport was considering drawing up new guidance on their design. Early (2007) [9] clearly identified the gap in England and Wales by stating that high streets, secondary retail streets and those connecting residential areas fall between the Manual for Streets and the DMRB which was prepared for motorways and trunk roads.

Dr Robert Eadie and Dr Phillip Millar
University of Ulster
United Kingdom
Corresponding Author email r.eadie@ulster.ac.uk

Mr John Boyle
RPS Consulting Engineers
United Kingdom

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An attempt has been made to fill this gap in England and Wales by the publication of Manual for Streets 2 (MfS2) in 2010 [10]. This states *"MfS2 builds on the guidance contained in MfS1, exploring in greater detail how and where its key principles can be applied to busier streets and non-trunk roads, thus helping to fill the perceived gap in design guidance between MfS1 and the Design Manual for Roads and Bridges (DMRB)".* MfS2 was published as a companion guide to the Manual for Streets (MfS1)".

Scotland followed in 2010, producing a policy statement for Scotland called Designing Streets [11]. Again this was predominantly for the design of residential streets but widened the application of the design principles to include high streets and other higher traffic volume streets in order to close the gap.

In Northern Ireland the gap in the design guidance was acknowledged in 2013 when the Urban Stewardship and Design Guide (USDG) on design of streets was submitted for public consultation [12]. However, this draft documentation has not provided geometric design properties for streets. The aim of the USDG is to establish the key principles behind good place making. It is at a higher level than the calculations required for street design seeking to inform those involved in managing (stewardship) and making (design) urban places. The design element concentrates on visualisation and access rather than highway design. Therefore the status quo remains.

Early (2007) cites Duggan stating that *"Because there is a policy gap the DMRB gets pulled down for secondary roads."* Applying the rigour of highway design in the DMRB TD 9/93 Table 3 [2] for high speed roads in a mixed use development can result in problems being created.

III. Case Study indicating Problems with using DMRB for Mixed Use Developments

RPS were appointed as consulting engineers for Titanic Quarter in Belfast to prepare a detailed master plan for the development [13]. One section of the design entailed a new 22.5m wide section of street with a 30mph speed limit in this mixed use, residential, retail, office and leisure development. To fit with the architectural master plan it was required to provide reverse back to back 127m horizontal radii to fit between the buildings.

Had the DMRB design criteria been applied, a 7% super elevation would have been needed for this street creating over 1m of level difference from one side to the other. Coupled with this level difference the super elevation would have required to switch from one side to the other within a short distance due to the reverse curve. This would upset the visual appearance of the scheme.

This illogical approach to the design of this street necessitated the application for formal departures from the Overseeing Organisation to depart from the onerous DMRB standards, which gives no consideration to a street lined with trees and adjoined by apartments, shops and offices. This calls for a separate design guide specifically for mixed use developments. This paper seeks through correlating the results of a number of case studies which used departures from the DMRB standards with the codes in England to provide guidance for certain street design criteria in mixed use developments.

IV. Method

This paper reviewed seven randomly selected case studies at existing locations in Northern Ireland where roads have been designed, approved, constructed and operational for a period of more than one year. However, the geometric properties of these locations fail to meet the standards set out in the DMRB and required relaxations of the DMRB design standards. The case studies include accident statistics from the Police Service of Northern Ireland to prove that reduced standards can still be applied safely. The criteria used for selection of case studies were:

1. The scheme was an existing city or town centre street;
2. It included an existing city or town centre junction, and;
3. Had geometry which is below the current design standards.

The case studies from Belfast were:-

1. Sydenham Road – Queens Quay in relation to a relaxation for Horizontal Alignment and stopping sight distance.
2. Donegall Quay – Albert Square in relation to a relaxation for Horizontal Alignment and stopping sight distance.
3. Cromac Street in relation to a relaxation to cross-section and lane width.
4. Victoria Street in relation to a relaxation to cross-section and lane width.
5. Linenhall Street – Donegall Square South in relation to a relaxation for junction visibility
6. Adelaide Street – Ormeau Avenue in relation to a relaxation for junction visibility and on-street parking.
7. Lisburn Road – Osborne Drive in relation to a relaxation for junction visibility and on-street parking.

These case studies allow investigation of two sites for each of horizontal alignment, cross-section and lane width, stopping sight distance, and on street parking. Three examples of relaxations for junction visibility are also provided.

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V. Case Study 1 - Sydenham Road / Queens Quay - Horizontal Alignment and stopping sight distance

Figure 1 indicates the layout of this junction

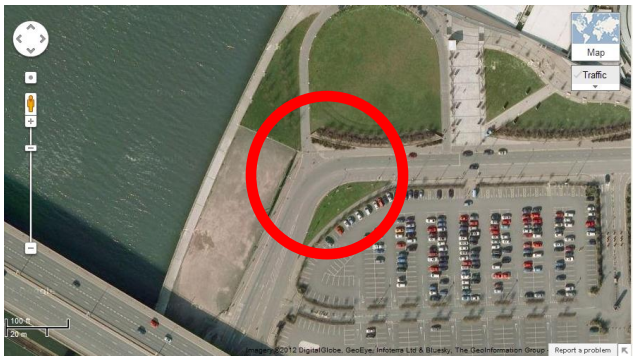

Figure 1 Sydenham Road / Queens Quay

Traffic flows on this street were 1358 AM and 1405 PM. The horizontal curvature at the junction is 30m. This is at the entrance to the development alongside the car park and not near any of the residential units on the mixed use development. Therefore the curvature parameters from Table 3 from the DMRB should apply resulting in a minimum curve of 90m and super elevation of 7%. No super elevation is present and the gully levels on both sides of the carriageway would confirm this. This geometry is therefore sub-standard in terms of the application of the DMRB design guidance.

Furthermore, the measured stopping sight distance around the horizontal curvature is 60m. This would not seem to be predominantly residential location as there are no apartments or houses in direct vicinity therefore the stopping sight parameters from Table 3 from the DMRB should apply resulting in a required stopping sight distance of 90m with a one step below desirable minimum of 70m.

Despite this the accident database indicates a single serious accident between 2006 and 2010 with one casualty outside the area of the red circle indicated on Figure 1, therefore not directly related to the junction.

VI. Case Study 2 - Donegall Quay – Albert Square - Horizontal Alignment and stopping sight distance

Figure 2 indicates the layout of this junction

Figure 2 Donegall Quay / Albert Square

Traffic flows on this street were much heavier than Case Study 1 at 2525 AM and 3047 PM. The horizontal curvature at the junction is 21m. This area is predominantly office and retail accommodation and again the curvature parameters from Table 3 from the DMRB should apply. This again results in a minimum curve of 90m and super elevation of 7%. Only a slight super elevation is present evidenced in the gullies being present only on the inside of the curve. This geometry is therefore sub-standard in terms of the application of the DMRB design guidance.

Furthermore, the measured stopping sight distance around the horizontal curvature is 45m. Again this is not a predominantly residential location and the parameters from Table 3 from the DMRB should apply resulting in a required stopping sight distance of 90m with a one step below desirable minimum of 70m.

Again the Accident database indicates only a single slight collision with a single casualty between 2006 and 2010. The single casualty fell into the slightly injured category.

VII. Case Study 3 - Cromac Street - cross-section and lane width

Figure 3 provides details of the street.

Figure 3 Cromac Street

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Traffic flows on this street were 2873 AM and 2310 PM. There are retail units, houses and apartments in the vicinity of this location. However, in the foreground of Figure 1 the street does not directly serve these residential units therefore the lane widths indicated in the DMRB Volume 6, Section 1, Part 2, TD 27/05 and TD 9/93 Clause 5.65 should apply. There is no specific guidance on lane widths within the DMRB for a 4 lane section of urban street with designers using the only comparable cross section of the Dual 2 Lane Carriageway (D2UAP) which is an urban all-purpose road and requires lane widths of 3.65m and a central reserve. Cromac Street has 4 lanes, 2 in either direction with no central reserve.

Figure 4 provides details of the accidents in Cromac Street from 2006-2010. The Accident database records the 4 not at junctions as slight collisions with 14 casualties. A closer examination of the locations of these incidents reveals that these are the ones indicated on Figure 4 that are not at junction locations or in queues of traffic leading to junctions.

This indicates that the lane width is not a criterion for the majority of accidents on this stretch of carriageway. Casualties were not in the killed, seriously injured or slightly injured categories, indicating they were involved but injury was very minor.

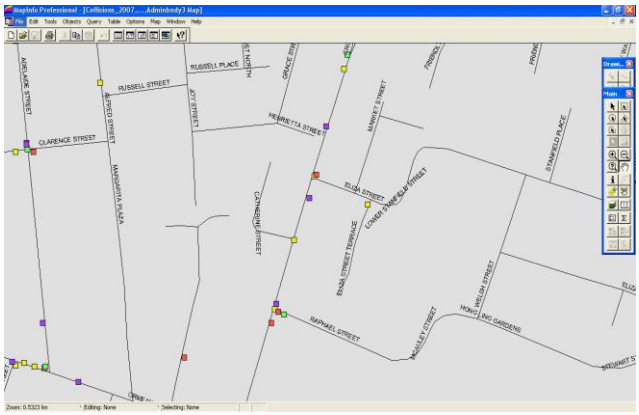

Figure 4 Accidents Cromac Street

VIII. Case Study 4 - Victoria Street - cross-section and lane width

Figure 5 provides details of the street. Traffic flows on this street were 2221 AM and 3736 PM. There are mainly retail units and office accommodation in the vicinity of this location. Again the lane widths indicated in the DMRB Volume 6, Section 1, Part 2, TD 27/05 and TD9/93 should apply. There is no specific guidance on lane widths within the DMRB for a 5 lane section of urban street.

Figure 5 Victoria Street

Designers use the only comparable cross section of the Dual 2 Lane Carriageway (D2UAP) which is an urban all-purpose road and requires lane widths of 3.65m and a central reserve. This section would also require central reserve with hard strips and a hard shoulder. Victoria Street has 5 lanes and is one way which means no central reserve is provided.

Figure 6 provides details of the accidents in Victoria Street from 2006-2010. The Accident database records the three incidents not at junctions as slight collisions with five casualties. The locations of these incidents are the ones indicated on Figure 6 that are not at junction locations or in queues of traffic leading to junctions.

This indicates that the lane width is not a criterion for the majority of accidents on this stretch of carriageway. Again, casualties were not in the killed, seriously injured or slightly injured categories, indicating they were involved but injury was very minor.

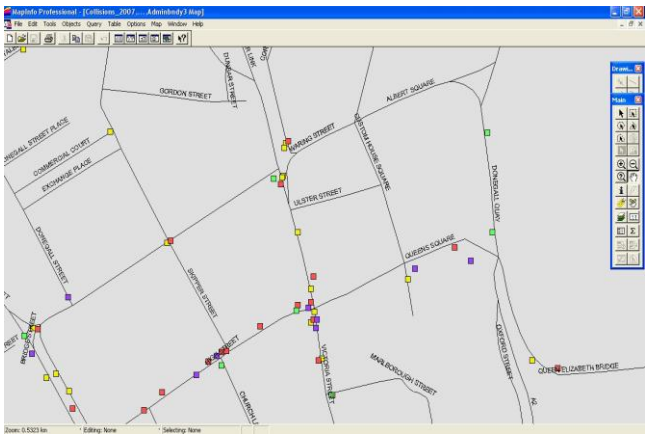

Figure 6 Accidents Victoria Street

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IX. Case Study 5 - Linenhall Street – Donegall Square South in relation to a relaxation for junction visibility

Figure 7 provides details of the junction

Figure 7 Linenhall Street – Donegal Square South Junction

At this junction the measured junction visibility provides an x-distance of 4.5m and a y-distance of 90m. This is not a predominantly residential area due to the presence of offices and retail and it is also not a private access. Therefore neither Creating Places nor DCAN15 are applicable. This means the stopping sight parameters from the DMRB including those in TD 9/93 Table 3 and TD 42/95 paragraphs 7.6c and 7.8 should apply resulting in a junction visibility zone with an x-distance of 9.0m and a y-distance of 90m. However a relaxation to 4.5m for the x-distance is allowable for lightly trafficked simple junctions. The visual assessment has also shown that there are trees, lamp posts and other obstructions within the visibility envelope which would not be allowed.

Despite this the accident database indicates two slight collisions between 2006 and 2010 with three casualties. Again, casualties were not in the killed, seriously injured or slightly injured categories, indicating they were involved but injury was very minor.

X. Case Study 6 - Adelaide Street – Ormeau Avenue in relation to a relaxation for junction visibility and on-street parking.

Figure 8 provides details of the junction. At this junction the measured junction visibility provides an x-distance of 4.5m and a y-distance of 90m. This is not a predominantly residential area due to the presence of offices and retail and it is also not a private access therefore neither Creating Places nor DCAN15 are applicable.

Figure 8 Adelaide Street – Ormeau Avenue Junction

This means the stopping sight parameters from the DMRB including TD 9/93 Table 3 and TD 42/95 paragraphs 7.6c and 7.8 should apply resulting in a junction visibility zone with an x-distance of 9.0m and a y-distance of 90m. However a relaxation to 4.5m for the x-distance is allowable for lightly trafficked simple junctions. The visual assessment has also shown that there are trees, street lighting, and car parking within the visibility zone which would not be allowed. There is also a signalised pedestrian crossing in close proximity to the junction which would not be allowed.

The accident database indicates three collisions in close proximity to this junction between the years 2006-2010. The collisions have been classified as one serious and two slight collisions. Again, the three casualties were not in the killed, seriously injured or slightly injured categories.

XI. Case Study 7 - Lisburn Road – Osborne Drive in relation to a relaxation for junction visibility and on-street parking.

Figure 9 provides details of the junction

Figure 9 Lisburn Road – Osbourne Drive Junction

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At this junction the measured junction visibility provides an x-distance of 4.5m and a y-distance of 90m. The measured junction visibility at Case Study No.7 is an x-distance of 4.5m and a y-distance of 90m. This junction could be classed as a private access from a residential area to a main road and therefore DCAN15 should apply to this access. The application of DCAN15 is then dependant on the traffic flow using the junction. As the access has a traffic flow of over 1000 vehicles per day then the desirable minimum x-distance should be 6m however this may be relaxed to 4.5m. The y-distance for the access should be 70m based on a vehicle speed of 31mph on the Lisburn Road. The visual assessment has also shown that there are trees, car parking and street lighting within the visibility envelope of the junction which is not allowed.

XII. Conclusions and Recommendations.

The case studies above support the following suggestions in respect of design criteria for preliminary geometric street design through interpolation of values from the DMRB and MFS1/MFS2 and application of reasoning from the analysed case studies. The case studies suggest a division of streets into three main categories, Primary, Secondary and Shared Carriageways having the following definitions:

1. Primary – A main heavily trafficked street with multiple lanes and used by pedestrians, cyclists, cars, delivery vehicles and buses (Example - Case Studies 3 and 4).
2. Secondary – A secondary access street with a medium volume of traffic for access to developments used by pedestrians, cyclists, cars and delivery vehicles (Example - Case Study 1)
3. Shared Surfaces – A minor street with low traffic volume used by pedestrians, cyclists, cars and small delivery vans (Example - Case Study 7).

The first two case studies support the determination of proposals for horizontal and vertical alignment. The DMRB TD 9/93 Table 3 [2] stipulates a minimum allowed horizontal curve for a 50kph design speed of 90m with a super elevation of 7%. The next radius above that is 127m with a super elevation of 7%. The ratio of difference between these two figures is 0.7. Manual for Streets 2 recommends minimum radii on based on minimum v^2/R values providing 28.28; this could be adopted. Applying the ratio of difference of 0.7 to 90m gives a radius of 65m and a subsequent radius of 44m. The case studies 1 and 2 indicate that these values would be safe. The DMRB TD 9/93 Clause 4.1 [2] specifies a value of 6% gradient for single carriageways; this should be maintained where possible. However Case studies 1 and 2 prove further flexibility can be given for secondary and shared streets.

Desirable minimum lane widths of 3.65m should be achieved as per DMRB TD9/93 Clause 5.56 on primary routes. Case studies 3 and 4 indicate Clause 3.14 value of 3.5m at pinch points can also be safely reduced.

The MFS1Figure 7.1 [8] suggests an absolute minimum value of 2.75m for lane width with no allowance for cyclists. Case study 3 shows that narrow lanes of 2.54m can function without a direct impact on safety. Therefore the minimum value in the MFS1of 2.75m can be adopted for streets.

The minimum allowed stopping sight distance for a 50kph design speed in the DMRB TD9/93 Table 3 [2] is 70m with a one step below value of 50m. Manual for Streets provides a Table 7.1 indicating 43M as the minimum including bonnet length. From the evidence of Case Studies 2, 5, 6 and 7, 45m is safe so the MFS1 value should be adopted.

Further work needs to be carried out to confirm the findings of this limited number of case studies. Should the work confirm the findings of this paper it is suggested that the values proposed be incorporated into guidance for streets in Northern Ireland in the proposed publication of the Living Places document.

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